MUSHROOM Disease Known as "Bubbles" Controlled by Exclusion and Eradication

Most commercial growers are familiar with the symptoms of the destructive disease of cultivated mushrooms known in the United States as bubbles or mycogone and in France as la môle. It is caused by a fungus called *Mycogone perniciosa*, which grows into the mushroom and transforms it to a distorted putrid mass. Soon after the parasite attacks a mushroom it produces a layer of white or brown spores over the surface of the diseased mushroom. These spores are spread about by currents of air, by insects, workmen, etc. They may be lifted or deposited by convection currents and blown about through the air like dust particles too small to be seen unless floating through a beam of light in a dark room. Like many other fungous spores, they are able to germinate and grow immediately if conditions are favorable, or to live through a long rest period under unfavorable conditions. They may infect healthy mushrooms, grow in soil or compost, or remain in a resting stage for several months or even years.

The recurrence or accumulation of the disease from one crop to another indicates that the Mycogone fungus either is remaining alive inside the house from one crop to another or is being carried into the house during one of the cultural operations. There are several possible methods of introducing the fungus into the house: (1) By air or on insects entering through doors or ventilators, (2) in water, (3) spawn, (4) compost, (5) soil, and (6) by workmen.

Burning sulphur and fumigating with formaldehyde between crops are practical methods of eradicating Mycogone from the house. Experiments have shown that the burning of one-fourth pound of sulphur per 1,000 cubic feet of air space in a closed container will kill Mycogone spores. When it is used as a combination insecticide and fungicide, sulphur should be burned at the rate of 5 pounds per thousand cubic feet of air space. Formaldehyde is used at the rate of 1 pound of the commercial preparation per 1,000 cubic feet of air space. Detailed methods of using formaldehyde are given in United States Department of Agriculture Circular 27. If either of these methods of disinfection is used there will be little or no disease due to inoculum persisting within the house from one crop to another.

The danger of infection due to spores carried into the house in the air or by insects can be materially reduced by removing spent mushroom manure and all mushroom refuse from the immediate vicinity of the house and occasionally disinfecting the soil around the house. Various solutions are suitable, such as lysol, 2 per cent; formalin, 2 per cent; or bichloride of mercury, 1 pound to 60 gallons.

Infection from contaminated water or spawn can be largely avoided by using water direct from deep wells and by using bottle spawn. To prevent the growth of green mold and other contamination in spawn bottles, spawn makers transfer bottle spawn under as nearly aseptic conditions as possible. Because of this there is little chance for Mycogone to be distributed in bottle spawn. Furthermore, if clear-cut cases of the distribution of disease in spawn should arise it would be a comparatively simple matter for the spawn maker to trace the source of infection and start again with clean cultures.

Mycogone Eradicated by Heat

A good "heat" in the mushroom house during the final fermentation is the most effective method known of eradicating Mycogone from

mushroom compost. All of the evidence at hand indicates than an air temperature of 120° F. for 48 hours in a mushroom house will eradicate the fungus from the air, compost, and soil. Obviously, this temperature must be obtained in all parts of the house to eradicate the fungus completely. Therefore it is advisable to use some means to circulate the air to prevent temperature layering. Some growers accomplish this by opening the ventilators very slightly, others set large electric fans tilted up at an angle of 45° in the center aisle. It is also advisable to raise the lower beds off the floor to allow a circulation of air under them. Even when these precautions are taken it often happens that the manure is too wet or overcomposted to heat the air in the house to 120°. To insure against this condition some growers are providing themselves with auxiliary steam-heating systems to obtain artificially the desired temperature in the house during the "heat." This practice has given satisfactory results in the United States Department of Agriculture experimental mushroom house since it was first used in 1928 and seems to be a logical step in the right direction.

Outbreaks From Infested Casing Soil

Circumstantial evidence indicates that most of the severe outbreaks of "bubbles" in commercial houses in the United States are due to infested casing soil. Losses from this source can be eliminated by avoiding the use of contaminated casing soil, which usually is soil from fields that have been fertilized with spent mushroom manure or that have been subject to the drainage overflow from such fields. To determine whether soil is contaminated, small test beds may be cased with soil samples out of fields from which soil will be taken for subsequent crops. If soil infestation becomes general and there is no Mycogone-free soil available, the fungus can be eradicated from the soil by placing it inside the mushroom house during the "heat." Soil to be treated in this way should be placed near the top of the house, where the temperature is highest, and a temperature of at least 120° F. must be maintained in the soil for 48 hours or more.

The spread of the disease by workmen can be largely prevented by a few common-sense rules. For example, men who have been working with contaminated casing soil should not be allowed to cut mushrooms without first washing their hands; likewise, the removal of the occasional diseased mushroom often occurring on beds that are otherwise clean should be made a separate job and not done by men who are cutting mushrooms for market.

After infection has become widespread in a house a moderate amount of loss is inevitable, but the disease can be somewhat reduced by growing the crop at a low temperature, 50° to 55° F.

From the foregoing discussion it is apparent that a complete program of control is necessary to combat the disease effectively. So far as possible the spores and mycelium of Mycogone must be eradicated from the house and all avenues of entrance must be closed. Since the causal organism is capable of rapid reproduction, the neglect of one source of inoculum may render useless the measures taken to control others. Because of the various conditions under which mushrooms are cultivated, each grower must plan a control program to suit best his individual needs. The measures outlined above apply particularly to the prevention of the disease in standard mushroom houses. In heavily

infested areas they will not assure a 100 per cent control, but if carefully followed they will prevent serious outbreaks and control the disease sufficiently for practical purposes.

EDMUND B. LAMBERT,
Associate Pathologist, Bureau of Plant Industry.

MUSHROOM Growing Risky Without Control Action for Insects and Mites

The growers of the cultivated mushroom *Agaricus campestris* have long been troubled with insect pests and mites, the infestations of which have gradually increased with the localization and growth of the industry to the point where they have made mushroom culture rather hazardous unless measures of prevention and control are constantly practiced.

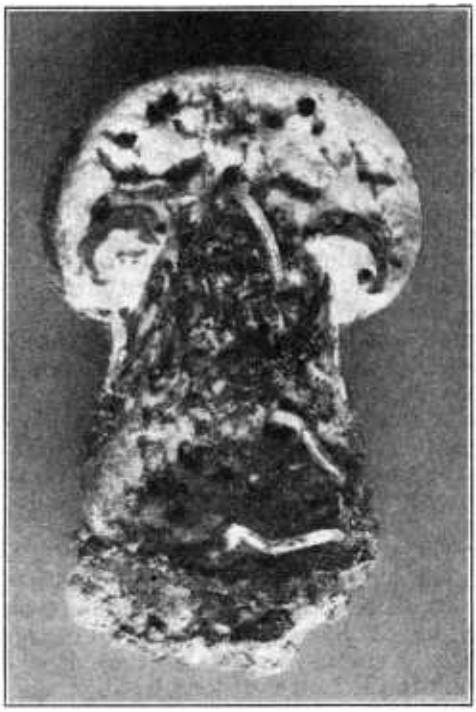

FIGURE 120.—Mushroom button showing maggots of fungus gnats and damage done chiefly by them

The chief pests causing commercial damage to mushrooms are the fungus gnats, mites, and springtails.

In general, the fungus gnats, of the genus Sciara, are productive of the most injury to the mushroom industry. They are prevalent in almost every type of mushroom house or cave, since they enter, as a rule, in the compost when it is taken into the houses. The larvae or maggots of these flies cause injury both by destroying the mycelium in the beds and by feeding on the small mushrooms, which they completely devour in many instances. These maggots are also capable of rendering the large sporophores unfit for market by tunneling upward through the stem and cap. (Fig. 120.) The adult flies often transport injurious mites, which attach themselves to the bodies of the flies, from one mushroom house to another and they also aid in the dissemination of some diseases of mushrooms.

The mites, while not so prevalent in general as the fungous gnats, are capable, nevertheless, of causing serious losses, once they become established in a range of mushroom houses. The mushroom mite proper, *Tyroglyphus lintneri* Osb., feeds on the mushroom, producing dark pits which result in decay, destroy the mycelium in the beds, and cut off the feeder "root system" (fig. 121) so that the sporophores do not mature, resulting in decreased yields. A severe infestation of this mite was experienced by an Ohio grower during the past season, resulting in a crop damage of approximately $25,000.